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(71) Applicant : **SAMSUNG ELECTRONICS Co., Ltd**
416 Maetan-Dong,
Paldal-gu
Suwon, Kyonggi-do (KR)

(72) Inventor : **Kim, Tae-Sig**
488-6, Wooman-dong,
Paldal-gu
Suwon-city, Kyungki-do (KR)
Inventor : **Choi, Jong-Su**
106-505, Hyundai Apart.,
Maetan-dong,
Paldal-gu
Suwon-city, Kyungki-do (KR)

(74) Representative : **Neill, Alastair William et al**
APPLEYARD LEES
15 Clare Road
Halifax, Yorkshire HX1 2HY (GB)

(54) Silencing device for vacuum cleaner.

(57) A silencing device for a vacuum cleaner. In a primary embodiment, the silencing device includes dampers (41,42) for absorbing operational vibration of a suction motor (1). The operational noises of the suction motor (1) are intercepted and suppressed by a middle case (30), a lower case (10), a bottom case (50) and a top case (20). The exhaust noises caused by exhaust air flow are repeatedly absorbed and suppressed by a plurality of exhaust ports (I - VIII). The exhaust air flow is also dispersed so as to suppress the exhaust noises. In the primary embodiment, the noises generated by both the suction motor (1) and the exhaust air flow are effectively suppressed to desired low levels. In a second embodiment, the silencing device comprises a noise absorber (61) for absorbing and suppressing both suction noises caused by suction air flow and operational noises of the suction motor (1). The silencing device also has a cover (62) for covering and supporting the front surface of the noise absorber (61). The back of the noise absorber is supported by a rear supporter (63). In the second embodiment, the noises generated by both the suction motor (1) and the suction air flow during suction of dirt-laden air by the suction motor (1) are effectively suppressed to desired low levels.

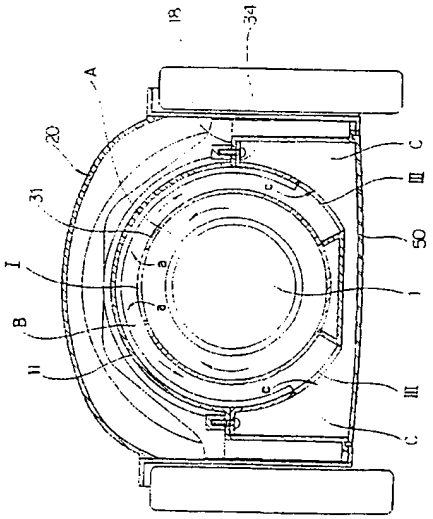

FIG.6

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The present invention relates in general to a silencing device of a vacuum cleaner for effectively suppressing noises of the vacuum cleaner such as caused by a suction motor, suction air flow and exhaust air flow and, more particularly, to an improved structure in such a silencing device of the vacuum cleaner for improving the noise suppressing effect.

In the prior art, there have been proposed and widely used several types of silencing devices for vacuum cleaners.

For example, Japanese U.M. Publication No. Sho. 62-45631 (applied on Oct. 23, 1981 and published on Dec. 7, 1987) discloses a silencing device for a vacuum cleaner which is shown in Figure 1 of the accompanying drawings.

As shown in Figure 1, the conventional silencing device for a vacuum cleaner comprises a suction motor 2' provided in a cleaner casing 1'. In Figure 1, the exhaust port provided on the back of the casing 1' for exhausting the purified air to the outside is designated by the numeral 3' - The suction motor 2' for generating suction force communicates with the exhaust port 31 through both an air path 4' and an exhaust silencer 5'. The exhaust silencer 5' defines an exhaust path 6' therein. In the above silencing device, the exhaust path 6' of the exhaust silencer 51 is slantly connected to the air path 41 at an obtuse angle. With the slant connection between the exhaust path 6' and the air path 4' of the casing 1', it is possible to suppress the turbulence noise caused by the exhaust air flow having already passed the suction motor 2'. In the above silencing device, the turbulence noise is partly absorbed and suppressed by a noise absorbing material 7'.

However, the above silencing device for a vacuum cleaner, while partly absorbing and suppressing the exhaust noise caused by the exhaust air flow having passed the suction motor 2', nevertheless has a problem that the exhaust air flow should pass through a relatively short path and be exhausted to the outside of the casing 1' from only one exhaust port 3' of the casing 1', so that it is impossible to achieve the desired noise absorbing and suppressing effect.

The conventional silencing device has no means for suppressing the suction noise caused by the suction motor 2' so that it cannot help letting the suction noise emit to the outside of the casing 1'. Furthermore, the conventional silencing device cannot effectively absorb and suppress the noise caused by the exhaust air flow of the suction motor 2'. In this regard, a vacuum cleaner equipped with the above silencing device cannot help emitting an excessive noise to the outside during its operation.

In addition, the conventional silencing device cannot suppress the noise caused by the suction air flow generated in the dirt collection chamber of the cleaner when the cleaner sucks dirt-laden air. The vacuum cleaner equipped with the above silencing device thus emits the excessive noise to the outside during its operation and this not only hurts the user's feelings but also deteriorates the quality of the vacuum cleaner.

It is, therefore, an aim of preferred embodiments of the present invention to provide a silencing device for a vacuum cleaner in which the aforementioned problems can be overcome and which more effectively absorbs and suppresses the noises of the cleaner, such as caused by the suction motor, exhaust air flow and suction air flow of the cleaner, thereby not only giving pleasure to the user but also improving the quality of the cleaner.

According to a first aspect of the invention, there is provided a silencing device for a vacuum cleaner comprising: damping means for absorbing operational vibration of a suction motor of the cleaner; noise intercepting means for intercepting operational noises generated by the suction motor; noise absorbing and suppressing means for absorbing and suppressing exhaust noises caused by an exhaust air flow having already passed through the suction motor; and noise dispersing means for dispersing the exhaust air flow.

In accordance with the above, noises generated by both the suction motor and the exhaust air flow are effectively suppressed to desired low levels, thus to give pleasure to the user and improve the quality of the vacuum cleaner.

Preferably, said noise absorbing and suppressing means comprises exhaust path means for guiding said exhaust air flow while absorbing and suppressing the exhaust noises.

Said exhaust path means preferably includes a first exhaust path for preliminarily absorbing and suppressing the exhaust noises while guiding said exhaust air flow, said first exhaust path being defined between said suction motor and a cover part of a middle case, said middle case receiving the suction motor therein.

Preferably, a second exhaust path is provided for secondarily absorbing and suppressing the exhaust noises while guiding the exhaust air flow already passed through said first exhaust path, said second exhaust path being defined between a cover of a lower case and said cover part of the middle case, said lower case receiving said middle case therein.

A third exhaust path is preferably provided for thirdly absorbing and suppressing the exhaust noises while guiding the exhaust air flow already passed through both the second exhaust path and an exhaust port of said middle case, said third exhaust path being defined between a bottom case and an outer cover of said middle case.

Said exhaust path means may include a fourth exhaust path defined between a second cavity of a lower case and a top case and may also include a fifth exhaust path defined between a third cavity of a lower

case and a top case.

Said noise dispersing means preferably comprises :

a plurality of exhaust ports for dispersing and suppressing the exhaust noises while passing the exhaust air flow therethrough; and

a plurality of exhaust ports provided with their respective noise absorbing filters.

Preferably, said noise intercepting means comprises :

a middle case preliminarily intercepting the operational noises of the suction motor;

a lower case and a bottom case, said lower and bottom cases secondarily intercepting the noises already intercepted by the middle case; and

a top case thirdly intercepting the noises already intercepted by both lower and bottom cases, thus to suppress emission of the noises to the outside of the cleaner.

The invention includes a vacuum cleaner provided with a silencer device in accordance with the first aspect.

Noises generated by both the suction motor and the suction air flow during suction of dirt-laden air by the suction motor can be effectively suppressed by this arrangement to desired low levels, thus to cause only a weak noise to be emitted to the outside and, as a result, give pleasure to the user and improve the quality of the vacuum cleaner.

According to a second aspect of the invention there is provided a silencing device for a vacuum cleaner comprising:

a noise absorber for absorbing and suppressing both suction noises caused by suction air flow and operational noises of a suction motor of the cleaner;

a cover for covering and supporting the front surface of said noise absorber; and

a rear supporter placed at the back of said noise absorber so as to support the back of the noise absorber.

Preferably, said noise absorber is made of a noise absorbing and suppressing material and has a center suction port for allowing suction of dirt-laden air into said suction motor, said noise absorber being also streamlined on its front surface and gradually radially outwardly increased in its thickness, thus to improve its noise absorbing and suppressing effect.

Said cover preferably opens toward said noise absorber and has a streamlined wall coinciding with the streamlined surface of said noise absorber, said cover also having a projection extending forward from the center of said streamlined wall.

The invention includes a vacuum cleaner provided with a silencing device in accordance with the second aspect.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic sectional view of a vacuum cleaner equipped with a conventional silencing device;

Figure 2 is a schematic sectional view of a vacuum cleaner having a silencing device in accordance with a first embodiment of the present invention;

Figure 3 is an exploded perspective view of the vacuum cleaner of Figure 2;

Figure 4 is a partially broken perspective view of the silencing device according to the first embodiment having a lower case receiving a middle case therein;

Figure 5 is a partially broken perspective view of the lower case of Figure 4;

Figure 6 is a sectional view of the rear section of the vacuum cleaner of Figure 2, showing an exhaust air flow;

Figure 7 is a schematic sectional view of a vacuum cleaner having a silencing device in accordance with a second embodiment of the present invention;

Figure 8 is a perspective view of the vacuum cleaner of Figure 7 free from a top case, showing a construction of the silencing device; and

Figure 9 is an exploded perspective view of the vacuum cleaner of Figure 7, showing the silencing device.

With reference to Figures 2 to 6, there is shown a silencing device for a vacuum cleaner in accordance with a first embodiment of the present invention. In the drawings, Figure 2 is a sectional view of the vacuum cleaner, Figure 3 is an exploded view of the vacuum cleaner, Figure 4 is a partially broken perspective view of a lower case receiving a middle case therein, Figure 5 is a partially broken perspective view of the lower case receiving no middle case therein, and Figure 6 is a sectional view of the rear section of the vacuum cleaner, showing the exhaust air flow in the rear section of the cleaner.

In Figures 2 to 6, a suction motor for suction of dirt-laden air suction into the cleaner as well as for exhaust of purified air to the outside of the cleaner is designated by the numeral 1. Lower and top cases defining the outer appearance of the cleaner are designated by the numerals 10 and 20 respectively. The lower case 10 receives a middle case 30 therein.

The lower case 10 also defines therein a dirt collection chamber 2 receiving a dirt collection bag. A middle case 30 is received in a middle case receiving chamber 12 of the lower case 10. The lower case 10 further includes a noise absorbing chamber 13 for absorbing the noise caused by the exhaust air flow having already passed through the suction motor 1. A first cavity 18' is provided in the lower case 10 in order for forming an exhaust path in cooperation with both a

bottom case, which will be described later herein, and the middle case 30 and absorbing and suppressing the noise caused by the exhaust air flow. The lower case 10 also includes second and third cavities 18" and 18'''. The second and third cavities 18" and 18''' of the lower case 10 cooperate with the top case 20 so as to define an exhaust path and to absorb and suppress the noises caused by the exhaust air flow.

In the lower case 10, the middle case receiving chamber 12 and the dirt collection chamber 2 are separated from each other by a support 14 having a suction port 141. The receiving chamber 12 and the noise absorbing chamber 13 are separated from each other by a partition 15 having an exhaust opening 151. The noise absorbing chamber 13 is also separated from the second cavity 18" by a partition wall 17.

In order to separate the second cavity 18" from the outside, the lower case 10 has a outer casing 16. The first cavity 18' of the lower case 10 is defined by both a cover 11 and rib fixing parts 18. The third cavity 18''' is formed about the dirt collection chamber 2.

The cover 11 is provided with a plurality of exhaust ports VI for exhausting the exhaust air flow having already passed through the noise-absorbing chamber 13. In the same manner, a plurality of additional ports VII are formed on an inside wall, the inside wall defining the dirt collection chamber 2.

The lower case 10 also has side exhaust ports VIII on its front opposite sides. The exhaust air is partly discharged to the outside through the side exhaust ports VIII which have their respective noise absorbing filters. The exhaust air is also partly discharged to the outside through a rear exhaust port V provided at the back of the lower case 10. In the same manner as described for the side exhaust ports VIII, the rear exhaust port V has a noise absorbing filter.

The suction motor 1 includes damping means for absorbing the vibration generated by the motor 1 and suppressing the vibrating noise.

That is, an annular front damper 41 having a suction port 411 is fitted over the front of the suction motor 1 in such a manner that a surface contact is achieved between the damper 41 and the front of the motor 1. The back of the suction motor 1 is provided with a rear center projection 3. This projection 3 is totally covered with a rear damper 42 of the cap type. With the front and rear dampers 41 and 42, the operational vibration of the suction motor 1 is reliably absorbed so that there is no vibrational noise in the suction motor 1 during the operation of the motor 1.

The middle case 30 includes a motor chamber 39, which chamber 39 receives the suction motor 1 therein. The motor chamber 39 not only intercepts the noise of the suction motor 1 but also defines a first exhaust path A for absorbing and reducing the noise caused by the exhaust air flow of the suction motor 1. The middle case 30 further includes a cavity 32 which defines, in cooperation with the lower case 10, a second exhaust path B.

That is, the middle case 30 includes a cover part 31 and a rear part 38 for forming the motor chamber 39 and receives the suction motor 1 in the motor chamber 39. The cavity 32 of the middle case 30 is defined by both the cover part 31 and an outer cover 35.

The second exhaust path B, formed between the lower case 10 and the middle case 30 when the middle case 30 is received in the chamber 12 of the lower case 10, should be provided with airtightness. The desired airtightness of the path B is achieved by an airtight flange 33 placed at the front of the cover part 31 of the middle case 30.

A damper support 37 is provided on the inner surface of the rear part 38 of the middle case 30. This support 37 partially receives the rear damper 42 so as to support the damper 42. On the other hand, an annular projection 36 extends from the outer surface of the rear part 38 and is fitted into the exhaust opening 151 of the lower case 10.

In order for provision of the airtightness between the exhaust opening 151 of the lower case 10 and the annular projection 36, an annular packing 361 is interposed between the opening 151 and the annular projection 36.

The outer cover 35 of the middle case 30 includes a pair of ribs 34 on its opposite side ends. The ribs 34 come into surface contact with the rib fixing parts 18 of the lower case 10 and are coupled to the fixing parts 18.

The cover part 31, the rear part 38 and the outer cover 35 of the middle case 30 include their respective exhaust ports I, II and III for exhausting the air.

The bottom case 50 is mounted on the bottom surface of the lower case 10.

The top case 20 is provided with pipe receiving hole 21 for detachably receiving a suction pipe (not shown).

The aforementioned elements are assembled into the silencing device for the vacuum cleaner as follows. In assembling the elements into the silencing device, the damping means comprising the front and rear dampers 41 and 42 is placed on the suction motor.

That is, the front damper 41 comes into surface contact with the front of the suction motor 1. The front damper 41 is, thereafter, fixed to the front of the motor 1. In the same manner, the rear damper 42 is fixedly attached to the rear projections 3 of the suction motor 1. The front and rear dampers 41 and 42 absorb the operational vibration of the suction motor 1 and suppress the vibrational noise of the motor 1.

After mounting the front and rear dampers 41 and 42 on opposite ends of the suction motor 1, the motor 1 is received in the motor chamber 39 of the middle case 30. At this time, the rear damper 42 is received in and supported by the damper support 37 of the mid-

dle case 30.

As a result of placing of the suction motor 1 in the motor chamber 39 of the middle case 30, the first exhaust path A is formed between the motor 1 and the cover part 31 of the middle case 30. The first exhaust path A guides the exhaust air flow out of the suction motor 1 and, as a result, absorbs and suppresses preliminarily the noise caused by the exhaust air flow.

The middle case 30 is, thereafter, placed in the lower case 10. In placing the middle case 30 in the lower case 10, the front surface of the front damper 41 mounted on the suction motor 1 comes into surface contact with the inner surface of the support 14 of the lower case 10. The airtight flange 33 of the middle case 30 comes, at its edge, into surface contact with a corresponding part of the inner surface of the lower case 10. In addition, the annular projection 36 of the middle case 30 is received in the exhaust opening 151 of the lower case 10 with airtight interposition of the annular packing 361 between them.

As a result of placing of the middle case 30 in the lower case 10, the second exhaust path B is formed between the cover 11 of the lower case 10 and the cover part 31 of the middle case 30. The second exhaust path B will guide the exhaust air flow, which flow has been already guided by the first exhaust path A so as to be preliminarily absorbed and suppressed in its noise. As a result of the second guide of the exhaust air flow by the second path B, the noise of the exhaust air flow is again absorbed and suppressed.

The placing of the middle case 30 as well as the suction motor 1 in the chamber 12 of the lower case 10 is followed by mounting of the bottom case 50 on the bottom surface of the lower case 10.

As a result of mounting of the bottom case 50 on the bottom surface of the lower case 10, a third exhaust path C is formed between the bottom case 50 and the outer cover 35 of the middle case 30. The third path C guides the exhaust air flow, which flow has already passed through the second path B and been discharged from the exhaust port III of the outer cover 35 of the middle case 30. As a result of the third guide for the exhaust air flow by the third path C, the noise of the exhaust air flow is absorbed and suppressed once more again.

When the top case 20 is coupled to the lower case 10 after the lower case 10 is coupled to the bottom case 50, the assembling of the casing of the vacuum cleaner is finished. As a result of coupling the top case 20 to the lower case 20, the fourth and fifth exhaust paths D and E are formed.

In the above vacuum cleaner, the noise of the exhaust air flow out of the suction motor 1 is repeatedly absorbed and suppressed by the noise absorbing and suppressing means comprising the first to fifth exhaust paths A to E.

The noise caused by the exhaust air flow out of the suction motor 1 is also dispersed by noise dispersing means, which dispersing means comprises the plurality of exhaust ports I, II, III, IV and VII and the plurality of exhaust ports V and VIII, the exhaust ports V and VIII being provided with their respective noise absorbing filters. With the noise dispersing by the dispersing means, the noise caused by the exhaust air flow from the suction motor 1 is effectively suppressed.

The noise suppressing effect of the above silencing device is doubled by the noise intercepting means. That is, with the noise intercepting means comprising the middle case 30, the lower case 10, the bottom case 50 and the top case 20, the operational noise caused by the suction motor 1 is not emitted to the outside but successfully intercepted.

The operational effect of the silencing device of the primary embodiment will be described hereinbelow.

When turning on a power switch (not shown), the dirt-laden air is sucked into the dirt collection chamber through a nozzle (not shown) and the suction pipe (not shown) by the suction force of the suction motor 1. In the dirt collection chamber equipped with a dirt collection bag, the dirt-laden air is filtered so as to be purified. The purified air is, thereafter, introduced into the suction motor 1 while the dirt remains in the dirt collection bag.

During operation of the suction motor 1, the motor 1 generates vibration which will cause vibrational noise. However, the vibration of the suction motor 1 is absorbed by the damping means so that the vibrational noise of the motor 1 is not emitted to the outside but suppressed.

The suction motor I also causes another noise or an operational noise such as caused by rotation of a rotor. However, this operational noise is preliminarily intercepted by the middle case 30 receiving the motor 1 therein and, thereafter, again intercepted by both the middle case receiving chamber 12 of the lower case 10 and the bottom case 50. The operational noise of the motor 1 is last intercepted by the top case 20.

That is, the operational noise of the suction motor 1 is repeatedly intercepted by the noise intercepting means, comprising the cases 10, 20, 30 and 50, thus to be successfully suppressed. In this regard, the operational noise of the motor 1 is not emitted to the outside.

In addition, the exhaust air flow out of the suction motor 1 generates an exhaust noise. However, this exhaust noise is absorbed and suppressed as the exhaust air flow passes in order through the exhaust ports A, B, C, D and E. The exhaust air flow is, thereafter, dispersed and discharged to the outside through the plurality of exhaust ports V and VIII of the lower case 10. In this regard, the exhaust noise of the vacuum cleaner is successfully suppressed and emitted to the outside as a lower level noise.

That is, the exhaust noise caused by the exhaust air from the suction motor 1 is absorbed and suppressed as the exhaust air flow passes through the noise absorbing and suppressing means comprising the exhaust ports A, B, C, D and E. The exhaust air flow is additionally dispersed and discharged to the outside through the noise dispersing means comprising exhaust ports V and VIII of the lower case 10. The exhaust noise of the vacuum cleaner is thus successfully suppressed and emitted to the outside as the lower level noise.

If described in detail, the exhaust air flow out of the suction motor 1 passes through the first exhaust path A formed between the suction motor 1 and the cover part 31 of the middle case 30. Thereafter, the exhaust air flow is partly discharged to the outside of the middle case 30 through the exhaust port I of the cover part 31 of the middle case 30 as shown at the arrow "a". The other part of the exhaust air flow is discharged, as shown at the arrow "b", to the outside of the middle case 30 through the exhaust port II formed on the rear part 38 of the middle case 30.

The exhaust air flow discharged from the exhaust port I of the cover part 31 of the middle case 30 in turn passes through the second exhaust path B formed between the cover 11 of the lower case 10 and the cover part 31 of the middle case 30. The exhaust air flow is, thereafter, discharged from the exhaust port III of the outer cover 35 of the middle case 30 as shown at the arrow "c" of Figure 4. The exhaust air flow out of the exhaust port III of the outer cover 35 passes through the third exhaust path C formed between the outer cover 35 of the middle case 30 and the bottom case 50. This exhaust air flow is, thereafter, discharged from the exhaust port VII of the lower case 10 as shown at the arrow "d" of Figure 3. The exhaust air flow out of the exhaust port VII of the lower case 10 passes through the fifth exhaust path E formed between the top case 20 and the lower case 10. This exhaust air flow is, thereafter, discharged from the lower case 10 through the exhaust port VIII of the lower case 10 as shown at the arrow "e" of Figure 3.

Here, the exhaust port VIII of the lower case 10 is provided with the noise absorbing filter so that the exhaust noise, which noise possibly remains in the exhaust air flow regardless of passing of the exhaust air flow through the exhaust paths A to E, is last absorbed and suppressed as the exhaust air flow passes through exhaust port VIII.

Meanwhile, the exhaust noise caused the exhaust air flow, which exhaust air flow has already passed through the suction motor 1, the first exhaust path A and the exhaust port II of the rear part 38 of the middle case 30 as shown at the arrow "b", is absorbed and suppressed by the noise absorbing chamber 13 of the lower case 10. The exhaust air flow, thereafter, passes through the exhaust ports VI of the cover 11 of the lower case 10 as shown at the arrow "f". The exhaust air flow out of the exhaust ports VI passes through the exhaust path E formed between the partition wall 17 of the lower case 10 and the top case 20 and, thereafter, exhausts to the outside through the rear exhaust port V of the lower case 10 as shown at the arrow "g" of Figures 2 to 4.

The exhaust port V of the lower case 10 is provided with the noise absorbing filter in the same manner as described for the exhaust port VIII so that the exhaust noise, which noise possibly remains in the exhaust air flow regardless of passing of the exhaust air flow through the exhaust paths A and B and the noise absorbing chamber 13, is last absorbed and suppressed as the exhaust air flow passes through exhaust port V.

In accordance with the silencing device of the above primary embodiment, the operational vibration of the suction motor 1 is absorbed by the damping means of the suction motor 1 so that the vibrational noise possibly caused by the vibration of the motor 1 is successively suppressed. The operational noise of the suction motor 1, which operational noise is caused by such as rotation of the rotor of the motor 1, is intercepted by the noise intercepting means and successfully suppressed in the casing of the vacuum cleaner. The exhaust noise caused by the exhaust air flow out of the suction motor 1 is absorbed and suppressed by both the noise absorbing and suppressing means and the noise dispersing means, thus to be suppressed and to become a lower level noise when emitted to the outside of the cleaner. With the above noise suppressing effect, the silencing device according to the primary embodiment gives pleasure to the user and improves the quality of the vacuum cleaner.

Turning to Figures 7 to 9, there is shown a silencing device for a vacuum cleaner in accordance with a second embodiment. Figure 7 is a sectional view of the vacuum cleaner having silencing means of the silencing device according to the second embodiment. Figure 8 is a perspective view of the cleaner having the silencing means. Figure 9 is an exploded perspective view of the silencing means.

In Figures 7 to 9, the silencing means designated by the numeral 60 comprises a noise absorber 61, a cover 62 and an absorber supporter 63. The silencing means 60 absorbs and suppresses both the operational noise of the suction motor 1 as well as the suction noise caused by the suction air flow during operation of the suction motor 1.

The noise absorber 61 of the silencing means 60 is made of a noise absorbing material and provided with a suction port 611 on its center for allowing suction of the dirt-laden air. The noise absorber 61 is gradually increased in its thickness in the direction from its center to its edge. The thickness variation of the noise absorber 61 is achieved by causing the front

surface of the noise absorber 61 to be streamlined. This streamlined surface of the absorber 61 is best seen in the sectional view of Figure 7. With the streamlined surface of the absorber 61, the noise suppressing effect of the absorber 61 is improved.

The cover 62 of the silencing means 60 covers the noise absorber 61 at the side of the streamlined surface of the absorber 61. In order to receive the noise absorber 61 and to meet with the streamlined surface of the absorber 61, the cover 62 opens backward and shaped so as to correspond to the streamlined surface of the absorber 61. The cover 62 has a projection 623 extending forward from the center of streamlined wall of the cover 62.

The streamlined wall of the cover 62 is provided with a radial rib structure 621 for causing the noises caused by both the suction air flow and the suction motor to be absorbed and suppressed by the noise absorber 61. In order to prevent a vortex flow of the sucked air but to let much more air be sucked into the suction motor 1, a rib structure 622 comprising a plurality of ribs are formed on the side surface of the projection 623.

The absorber supporter 63 of the silencing means 60 is fitted into the opening of the cover 62, thus to support the noise absorber 61 placed in the cover 62. The absorber supporter 63 is opened at its center and provided with a boss 631 about its center opening, thus to prevent possible abrasion of the noise absorber 61 caused by the suction air flow.

In the drawings, the lower case 10 receives the suction motor 1 in its back. The lower case 10 also has, at its front section, the dirt collection chamber 2 having a dirt collection bag (not shown).

The lower case 10 is also provided at its middle section or at the front of the suction motor 1 with a support 70 for supporting the silencing means 60.

The support 70 of the lower case 10 includes a support surface 721, at which support surface 721 the support 70 comes into surface contact with the cover 62 of the silencing means 60 for supporting the means 60. A support flange 724 radially inwardly extends from the edge of the support surface 721 and retains the cover 62 in its place. With the support flange 724, the cover 62 is prevented from being suddenly separated toward the dirt collection chamber 2. The support 70 also includes a pair of fixing surfaces 722 at its opposite side ends. The fixing surfaces 722 having their respective threaded holes 723 are coupled to opposite flanges 742 of an arcuate fixing member 74 by bolts 75, which fixing member 74 and bolts 75 will be described later herein. At the back of the support 70, a support ring 71 is integrally formed with the support 70 for supporting the absorber supporter 63 of the silencing means 60 as well as for supporting damping means 80, which damping means 80 will be described later herein. With the support ring 71, the absorber supporter 63 of the silencing means 60 is prevented from being suddenly separated toward the suction motor 1.

The center of the support ring 71 is opened so as to form a suction opening 711. The suction opening 711 of the support ring 71 allows the air, which air has already passed through both the rib structure 622 of the cover 62 and the suction port 611 of the noise absorber 61, to be sucked into the suction motor 1 therethrough.

The damping means 80 is placed between the support ring 71 and the suction motor 1 as shown in Figure 7. The damping means 80 not only prevents possible leakage of sucked air but also absorbs the operational vibration of the suction motor 1.

The arcuate fixing member 74 tightens the cover 62 of the silencing means 60 so as to retain the silencing means 60 in its place. This fixing member 74 includes an arcuate surface part 741 which comes into tight contact with the upper surface of the cover 62 for supporting the cover 62 in its place. The opposite flanges 742 of the fixing member 74 extend from the opposite ends of the arcuate surface part 741 and come into contact with the fixing surfaces 722 of the support 70 respectively. The opposite flanges 742 are also provided with their respective threaded holes 743 which correspond to the threaded holes 723 of the support 70.

When placing the silencing means 60, the means 60 is seated on the support 70 and, thereafter, tightened by the arcuate fixing member 74. At this time, the fixing member 74 is placed on the cover 62 of the means 60 in such a manner that the member 74 comes into surface contact with the upper surface of the cover 62. After placing the fixing member 74 on the cover 62, the opposite flanges 742 of the fixing member 74 are screwed to the fixing surfaces 722 of the support 70 by the bolts 75. When tightening the bolts 75 received in both the threaded holes 743 and 723, the silencing means 60 is tightly seated in its place.

The lower case 10 is coupled to the top case 20 so as to form the dirt collection chamber 2 therebetween. In accordance with the present invention, it is preferred to let the cases 10 and 20 have good outer appearances since they form the outer appearance of the vacuum cleaner.

The top case 20 is provided with a pipe inlet 21 for detachably receiving a suction pipe 91, which pipe 91 connects the outer casing of the cleaner to a nozzle (not shown).

The outer casing of the vacuum cleaner comprises the lower case 10 and the top case 20 which are coupled to each other.

The operational effect of the silencing device of the second embodiment of this invention will be given hereinbelow.

When turning on a power switch (not shown), the dirt-laden air is sucked into the dirt collection cham-

ber 2 through a nozzle (not shown) and the suction pipe 91 by the suction force of the suction motor 1. In the dirt collection chamber 2 equipped with a dirt collection bag (not shown), the dirt-laden air is filtered so as to be purified. The air is, thereafter, introduced into the suction motor 1 so as to be exhausted to the outside of the cleaner while the dirt remains in the dirt collection bag.

During operation of the suction motor 1, the motor 1 generates operation noise. However, the operational noise of the suction motor 1 is partly emitted to the dirt collection chamber 2 through the suction opening 711 of the support ring 71, the suction port 611 of the noise absorber 61 and the rib structure 622 of the cover 62. The operational noise is also reflected in the dirt collection chamber 2 and absorbed by the noise absorber 61 through the rib structure 621 of the cover 62 of the silencing means 60. The operational noise of the suction motor 1 is thus suppressed.

That is, the operational noise of the suction motor 1 emitted to the dirt collection chamber 2 is not emitted to the outside of the cleaner through the pipe 91 but absorbed by the noise absorber 61 of the silencing means 60, thus to be suppressed.

In operation of the vacuum cleaner, the dirt-laden air is sucked into the dirt collection chamber 2 through the nozzle and the suction pipe 91 by the suction force of the suction motor 1. In the dirt collection chamber 2, the dirt-laden air is filtered so as to be purified. The air is, thereafter, introduced into the suction motor 1 so as to be exhausted to the outside of the cleaner while the dirt remains in the dirt collection bag.

At this time,the air sucked into the suction motor 1 is minimized in its frictional resistance and smoothly flows along the streamlined wall of the cover 62, thus to be introduced to the rib structure 622 of the projection 623 of the cover 62.

Here, since the air flows along the streamlined wall of the cover 62 so as to be introduced to the rib structure 622 of the projection 623 of the cover 62, it is minimized in its frictional resistance. In this case, a noise which is generated by the air flow is partly absorbed by the noise absorber 61 through the rib structure 621 of the cover 62, thus to be suppressed.

The noise of the air flow which is not still absorbed by the noise absorber 61 is reflected by the inner surface of the dirt collection chamber 2 and absorbed by the noise absorber 61 of the silencing means 60.

In the same manner as described for the operational noise of the suction motor 1, the suction noise caused by the suction air flow in the dirt collection chamber 2 is thus not emitted to the outside of the cleaner through the pipe 91 but absorbed by the noise absorber 61 of the silencing means 60, thus to be suppressed.

The cover 62 of the silencing means 60 has the center projection 623 having the rib structure 622. When large amount of air is introduced to the rib structure 622 of the front projection 623, there is generated no vortex in the rib structure 622 and this lets much more air be sucked to the suction motor 1.

As described above, the silencing device according to the above second embodiment absorbs, using a noise absorber of silencing means, both the operational noise of the suction motor and the suction noise caused by suction of dirt-laden air. In this regard, the noises of the vacuum cleaner is more effectively suppressed. With the above noise suppressing effect, the silencing device according to the second embodiment gives pleasure to the user and improves the quality of the vacuum cleaner.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A silencing device for a vacuum cleaner comprising :

damping means (41,42) for absorbing operational vibration of a suction motor (1) of the cleaner;

noise intercepting means (30,10,50,20) for intercepting operational noises generated by said suction motor;

noise absorbing and suppressing means (A-E) for absorbing and suppressing exhaust noises caused by an exhaust air flow having already passed through said suction motor; and

noise dispersing means (I - VIII) for dispersing said exhaust air flow.

2. The silencing device according to Claim 1, wherein said noise absorbing and suppressing means (A - E) comprises exhaust path means for guiding said exhaust air flow while absorbing and suppressing the exhaust noises.

3. The silencing device according to Claim 2, wherein said exhaust path means includes a first exhaust path (A) for preliminarily absorbing and suppressing the exhaust noises while guiding said exhaust air flow, said first exhaust path (A) being defined between said suction motor (1) and a cover part (31) of a middle case (30), said middle case (30) receiving the suction motor (1) therein.

4. The silencing device according to Claim 3, further comprising a second exhaust path (B) for secondarily absorbing and suppressing the exhaust noises while guiding the exhaust air flow already passed through said first exhaust path (A), said second exhaust path (B) being defined between a cover (11) of a lower case (10) and said cover part (31) of the middle case (30), said lower case (10) receiving said middle case (30) therein.

5. The silencing device according to Claim 4, further comprising a third exhaust path (C) for thirdly absorbing and suppressing the exhaust noises while guiding the exhaust air flow already passed through both the second exhaust path (B) and an exhaust port (III) of said middle case (30), said third exhaust path (C) being defined between a bottom case (50) and an outer cover (35) of said middle case (30).

6. The silencing device according to any of Claims 2 to 5, wherein said exhaust path means includes a fourth exhaust path (D) defined between a second cavity of a lower case (10) and a top case (20).

7. The silencing device according to any of Claims 2 to 6, wherein said exhaust path means includes a fifth exhaust path (E) defined between a third cavity of a lower case (10) and a top case (20).

8. The silencing device according to any of the preceding Claims, wherein said noise dispersing means (I - VIII) comprises :

a plurality of exhaust ports (I - VIII) for dispersing and suppressing the exhaust noises while passing the exhaust air flow therethrough; and

a plurality of exhaust ports (I - VIII) provided with their respective noise absorbing filters.

9. The silencing device according to any of the preceding Claims, wherein said noise intercepting means (30,10,50,20) comprises :

a middle case (30) preliminarily intercepting the operational noises of the suction motor (1);

a lower case (10) and a bottom case (50), said lower (10) and bottom (50) cases secondarily intercepting the noises already intercepted by the middle case (30); and

a top case (20) thirdly intercepting the noises already intercepted by both lower (10) and bottom cases (50), thus to suppress emission of the noises to the outside of the cleaner.

10. A vacuum cleaner provided with a silencer device in accordance with any of Claims 1 to 9.

11. A silencing device for a vacuum cleaner comprising:

a noise absorber (61) for absorbing and suppressing both suction noises caused by suction air flow and operational noises of a suction motor (1) of the cleaner;

a cover (62) for covering and supporting the front surface of said noise absorber (61); and

a rear supporter (63) placed at the back of said noise absorber (61) so as to support the back of the noise absorber.

12. The silencing device according to Claim 11, wherein said noise absorber (61) is made of a noise absorbing and suppressing material and has a center suction port (611) for allowing suction of dirt-laden air into said suction motor (1), said noise absorber being also streamlined on its front surface and gradually radially outwardly increased in its thickness, thus to improve its noise absorbing and suppressing effect.

13. The silencing device according to Claim 11 or 12, wherein said cover (62) opens toward said noise absorber (61) and has a streamlined wall coinciding with the streamlined surface of said noise absorber (61), said cover also having a projection (623) extending forward from the center of said streamlined wall.

14. A vacuum cleaner provided with a silencing device in accordance with any of Claims 11 to 13.

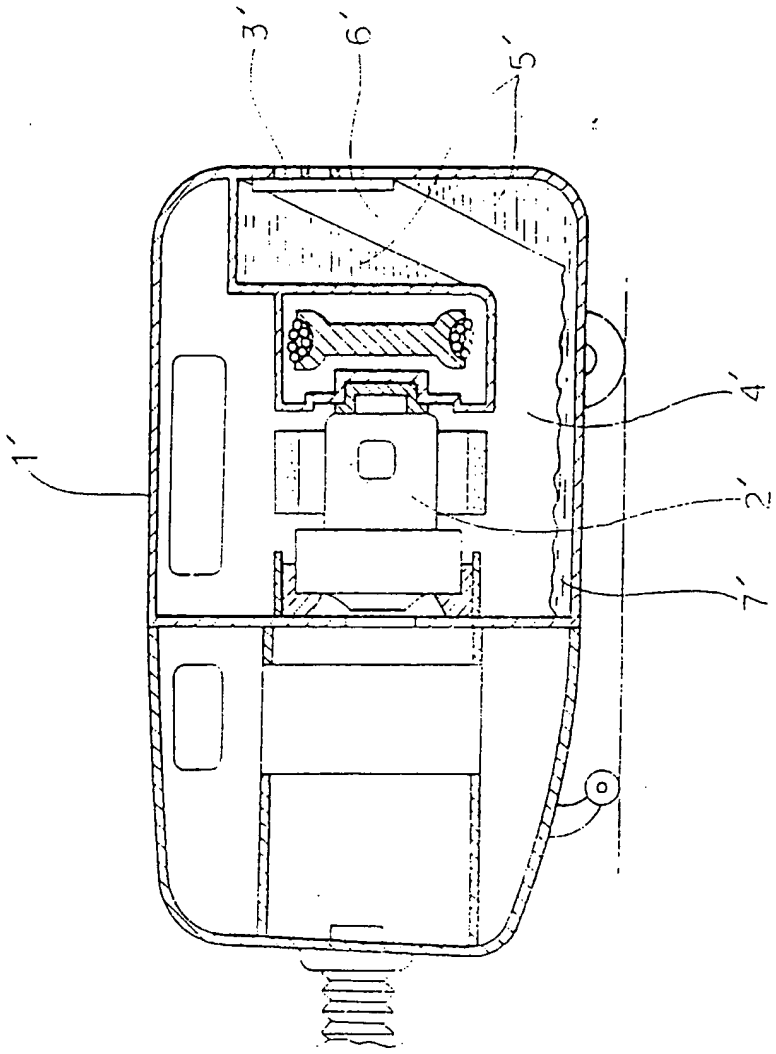

FIG. 1
(Prior Art)

FIG. 2

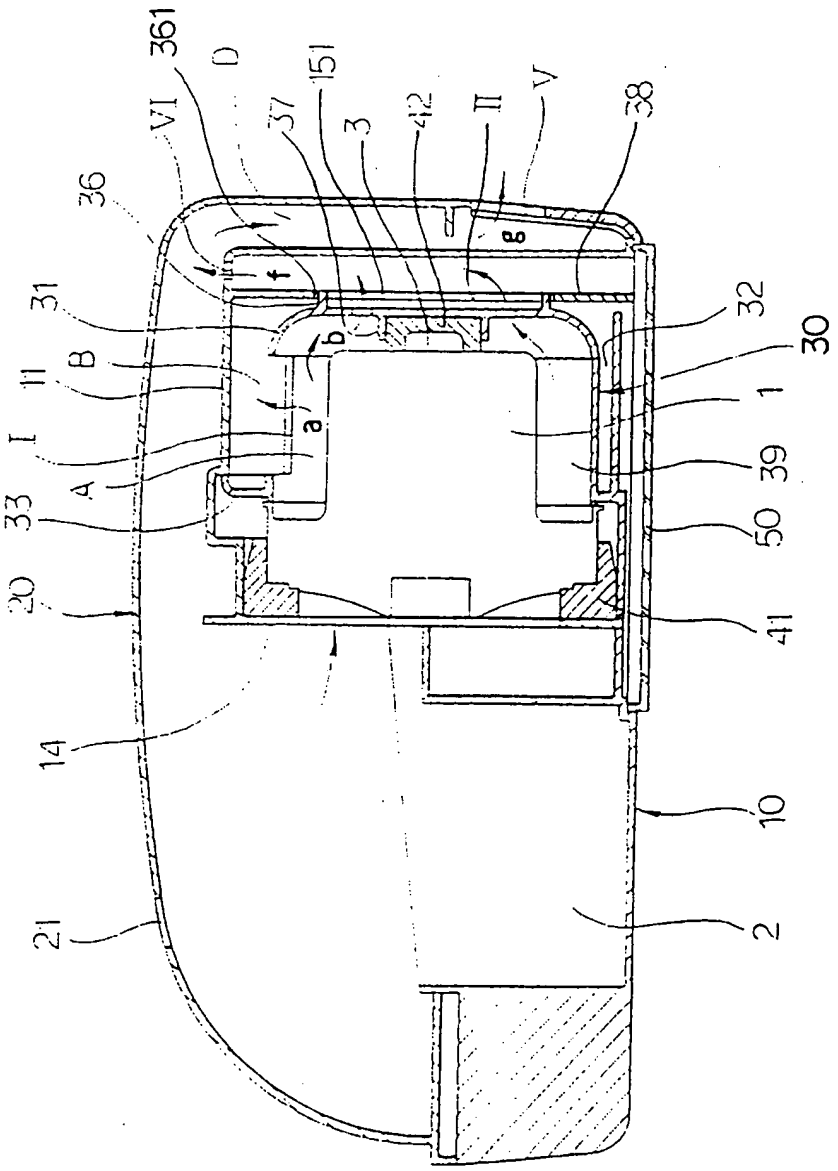
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FIG. 3

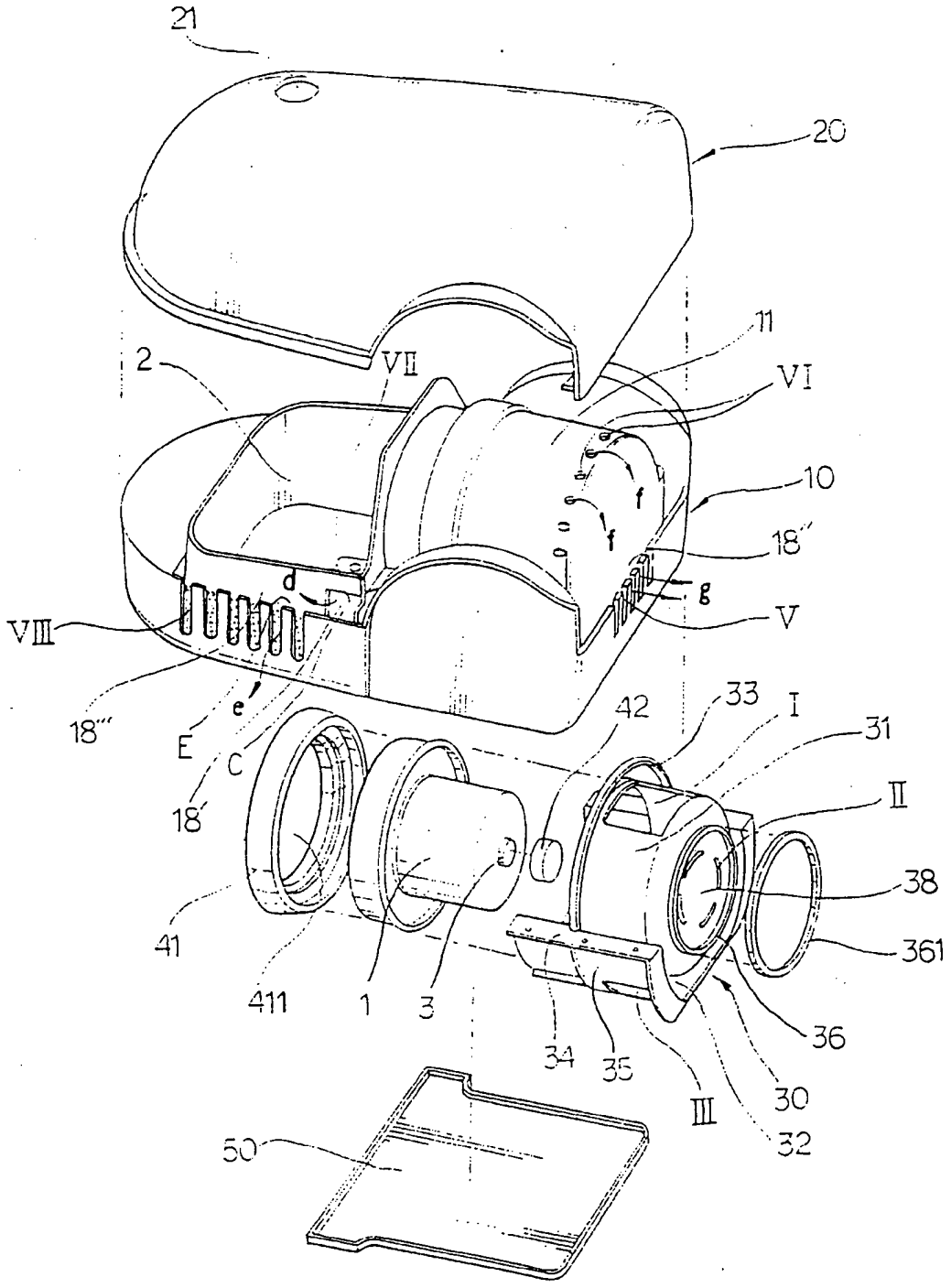
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FIG. 4

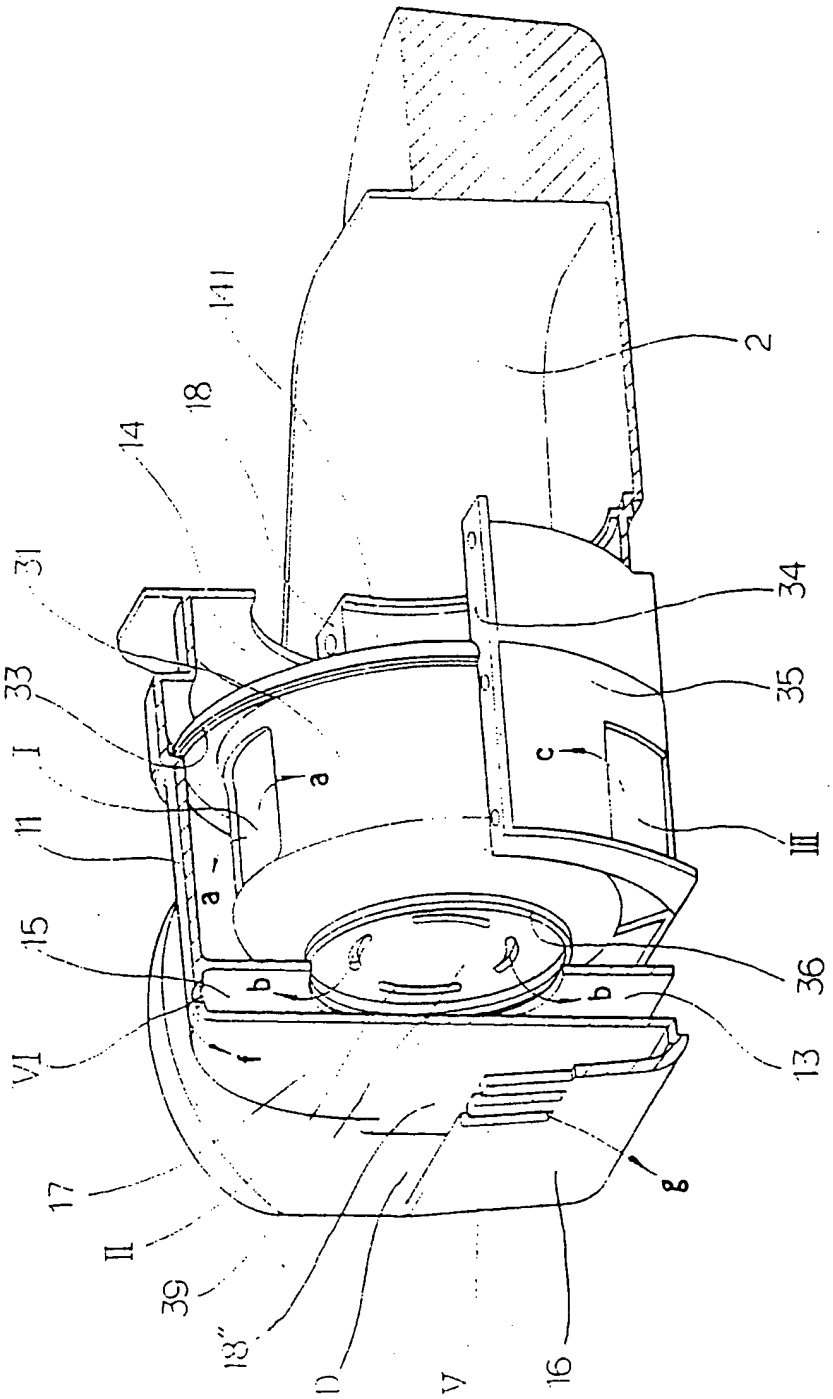


FIG. 5

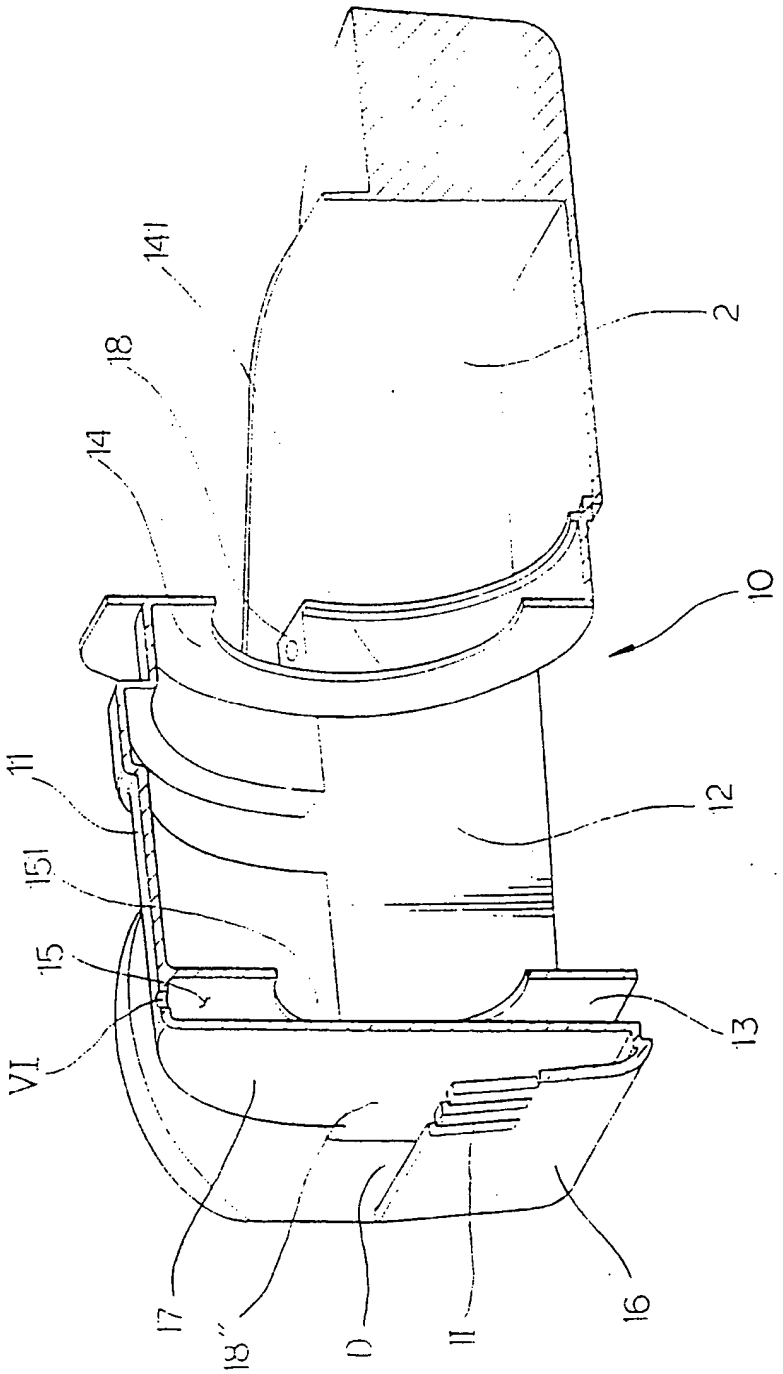


FIG.6

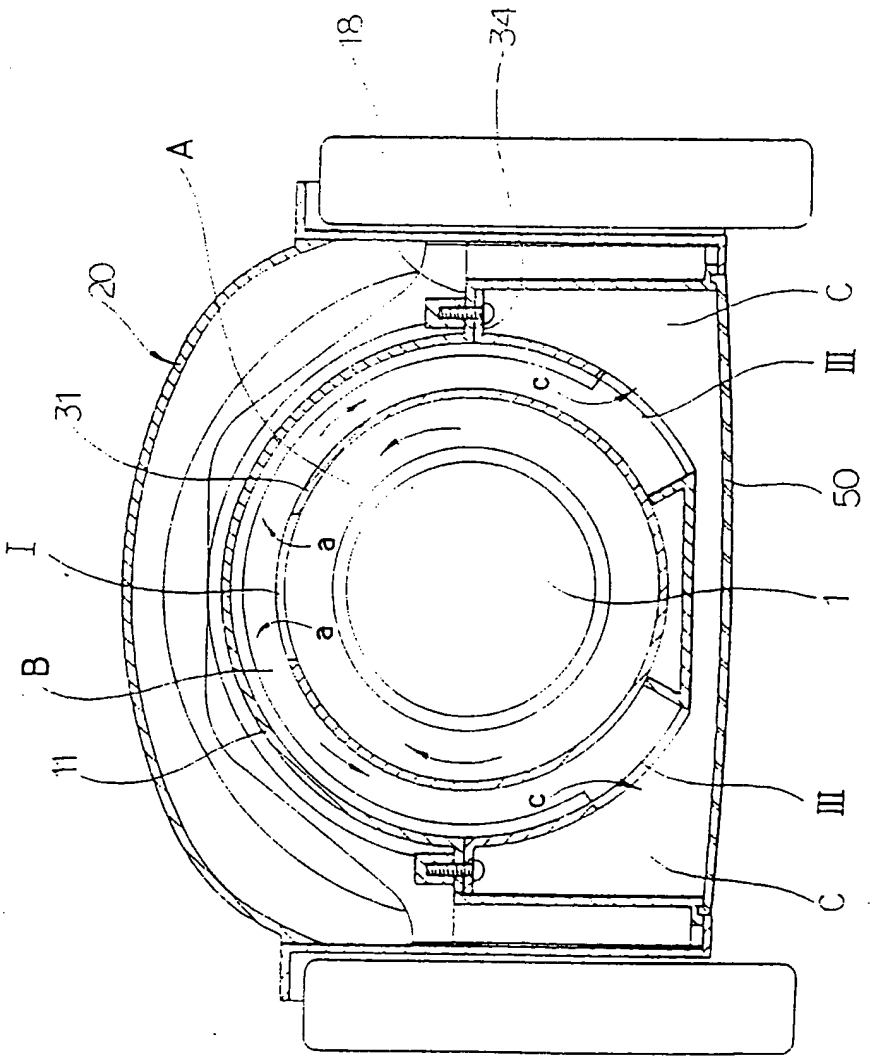


FIG. 7

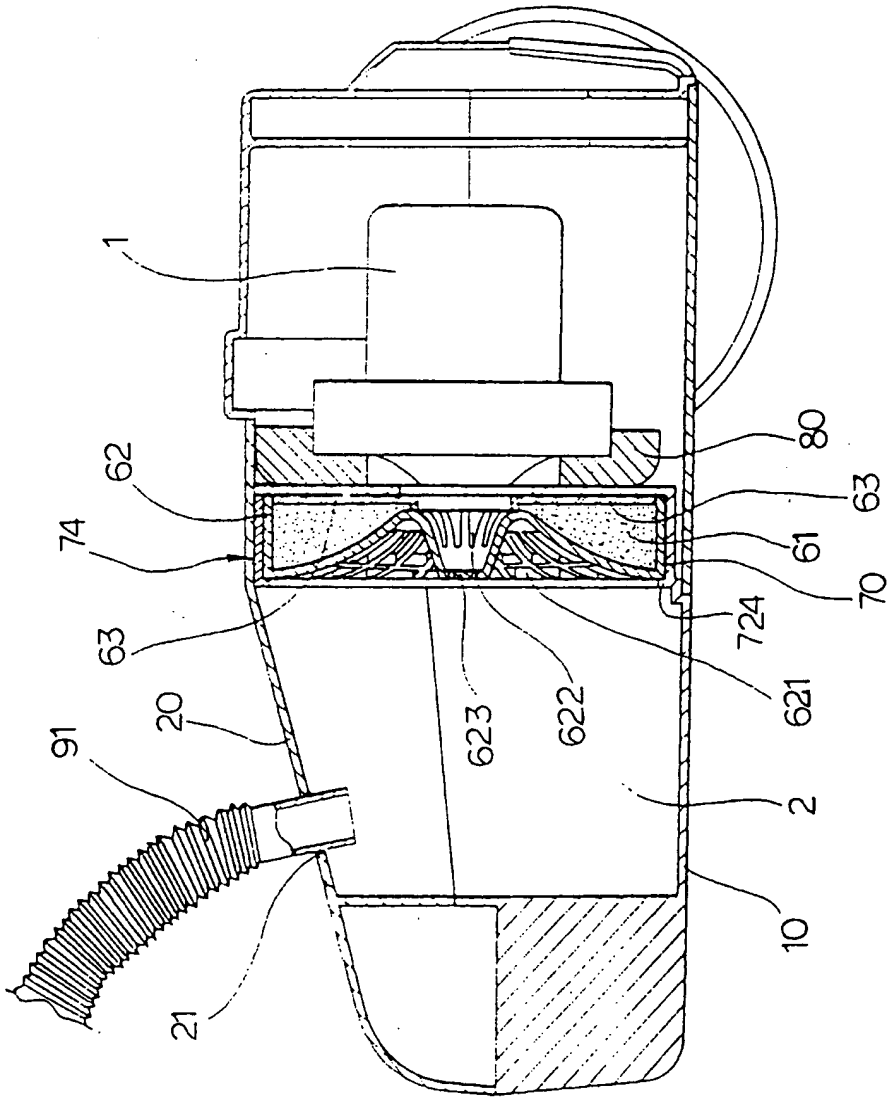


FIG.8

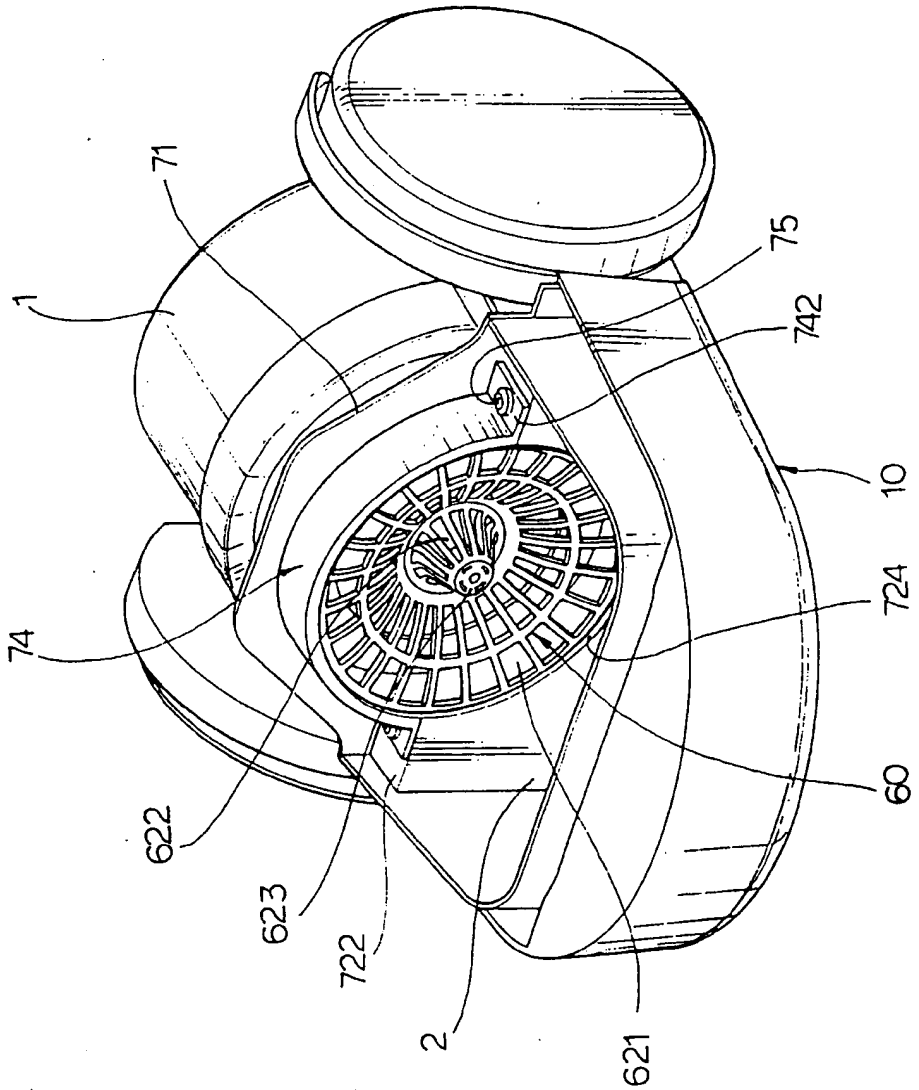
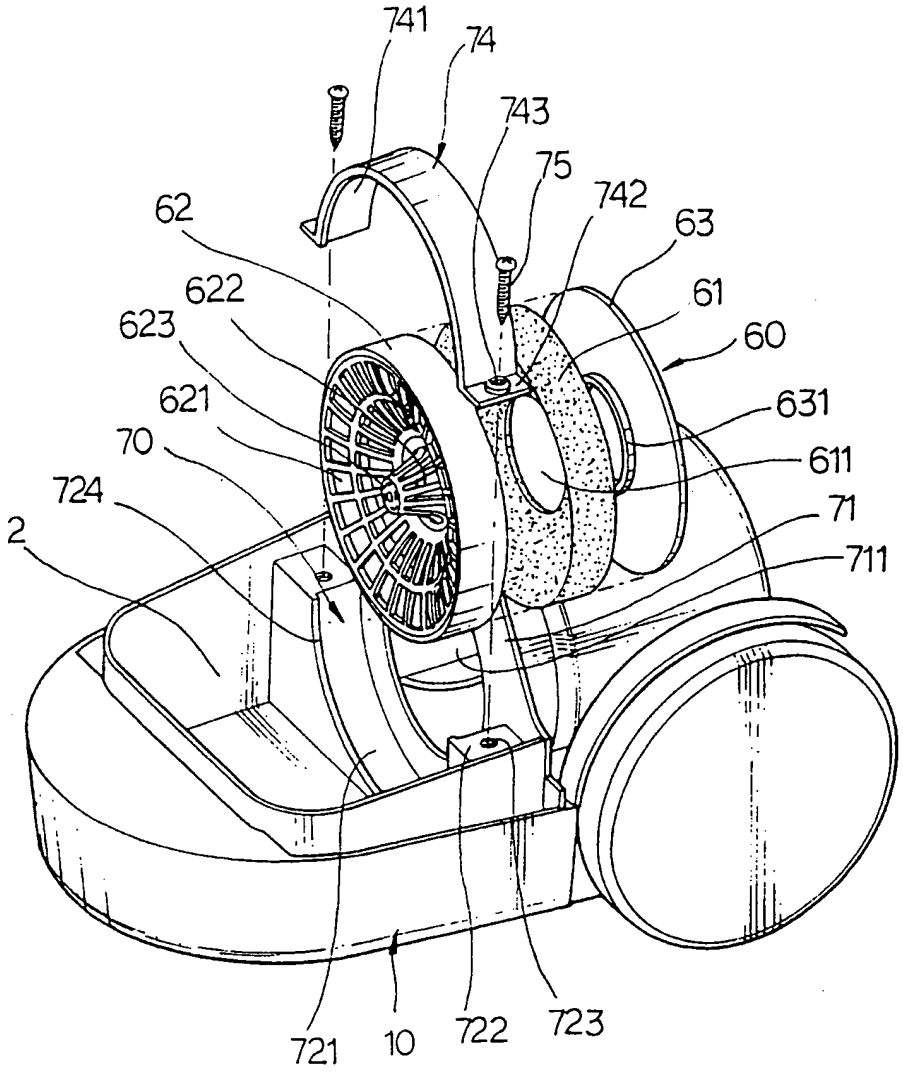


FIG.9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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5266

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 528 451 (DAEWOO ELECTRONICS CO LTD) * page 4, line 44 - page 8, line 33; figures 1-5 *	1-10	A47L9/00
A	EP-A-0 382 926 (PROGRESS ELEKTROGERAETE GMBH) * column 3, line 47 - column 4, line 57; figures *	1-10	
A	DE-A-41 00 858 (SIEMENS AG) * column 2, line 31 - column 5, line 15; figures *	1-10	
A	EP-A-0 345 699 (HITACHI LTD) * column 6, line 15 - column 12, line 56; figures *	1-10	
A	DE-C-641 371 (AEG) * the whole document *	1-10	
P,A	PATENT ABSTRACTS OF JAPAN vol. 17, no. 591 (C-1125) 28 October 1993 & JP-A-05 176 868 (NIPPON PETROCHEM CO LTD) 20 July 1993 * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) A47L
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 329 (C-0963) 17 February 1992 & JP-A-04 096 721 (MITSUBISHI ELECTRIC HOME APPLIANCE CO LTD) 30 March 1992 * abstract *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 October 1994	Vanmol, M

CATEGORY OF CITED DOCUMENTS

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